

Enhanced Water Quality Monitoring and Modeling Program for the A.R.M. Loxahatchee National Wildlife Refuge Quarterly Update Report – January 2006

Prepared by:

Matt Harwell, A.R.M. Loxahatchee National Wildlife Refuge

With contributions from Laura Brandt, Leslie MacGregor (NPS), Donatto Surratt,
and Mike Waldon

Overview

This update is a summary of activities since the previous status report of September 2005 on the implementation of the Refuge's Enhanced Water Quality Monitoring and Modeling Program. A project overview, and other detailed information about the program can be found at: http://sofia.usgs.gov/lox_monitor_model/. The primary objective of this overall program focuses on providing information for use in ecological management of the Refuge (Brandt et al. 2004; Harwell et al. 2005).

The Refuge's monitoring component of this program also addresses one of the Consent Decree Principals recommendations (17 December 2003):

B. Enhancing Monitoring of the Refuge

Design and implement an enhanced monitoring program to improve spatial and temporal understanding of factors related to phosphorus dynamics.

The Refuge's modeling component of this program also addresses several of the Consent Decree Principals recommendations (17 December 2003):

C. Modeling of the Refuge

- 1. Develop a water quality/hydraulic model for the Refuge with a phosphorus cycling component.*
- 2. Evaluate issues associated with phosphorus loads and transports within the L-40 and L-7 canals.*
- 3. Develop and track a simple phosphorus mass-balance model for the Refuge.*

Information Availability

Through collaboration with USGS, information from the Refuge's Enhanced Water Quality Monitoring and Modeling Program has been made available on the USGS' SOFIA web site at: http://sofia.usgs.gov/lox_monitor_model/. The web site is being updated in early 2006 to incorporate several reports generated since the previous updated, including:

- 1) Diaz, O. A., and Waldon, M. G. (2006). "L-40 Canal Sediment Elevation Study: Initial Report." Report #LOXA05-009, Everglades Research and Education

- Center, University of Florida, Belle Glade and Arthur R. Marshall Loxahatchee National Wildlife Refuge, U.S. Fish and Wildlife Service, Boynton Beach, FL.
- 2) MacGregor, L. (2006) "LOXA Sampling Locations - Coordinates and metadata." Report #LOXA06-001, Arthur R. Marshall Loxahatchee National Wildlife Refuge, U.S. Fish and Wildlife Service, Boynton Beach, FL.
 - 3) Surratt, D. (2005) "Enhanced Water Quality Program Parameter Reduction Report." Report #LOXA05-004, Arthur R. Marshall Loxahatchee National Wildlife Refuge, U.S. Fish and Wildlife Service, Boynton Beach, FL.
 - 4) Surratt, D. (2005) "S5A-CELL CANAL CROSS-SECTION STUDY." Report #LOXA05-015, Arthur R. Marshall Loxahatchee National Wildlife Refuge, U.S. Fish and Wildlife Service, Boynton Beach, FL.

Final data for monthly samples continue to be publicly posted on DBHYDRO by the SFWMD at: (<http://www.sfwmd.gov/org/ema/dbhydro/index.html>).

Monitoring Update (August – December 2005)

Sampling of the enhanced water quality monitoring network (Figure 1) occurred at 24 stations in August 2005, 36 stations in September 2005, 33 stations in October 2005, 35 stations in November 2005, and all 39 stations in December 2005 (Table 1).

Total phosphorus data for 2005 are presented in Table 1. Maps of TP for August – December 2005 are presented in Figures 2-6.

Conductivity sonde deployment information for 2005 is presented in Table 2.

Modeling Update

Model development (contract with University of Louisiana – Lafayette) continues. A draft model selection report and a draft model data report are currently being finalized. Concurrent with the completion of the model selection report will be the finalization of the first report from the modeling external technical review panel (contract with Tennessee Technological University). Members of the review panel felt that no definitive recommendation on model selection was appropriate prior to development of a more complete inventory of data that will be available to support model development. The modeling team has now substantially completed the data inventory task, and the review panel has received a draft copy of the data inventory report. It is anticipated that further recommendations from the advisory panel will be documented early in 2006.

The modeling team is also developing simplified water budget and mass budget models for the Refuge. Currently, a prototype water budget model has been developed and calibrated for the ten year period of record from 1995 to 2004. For some applications, this simplified modeling can provide valuable insight in support of management decisions. At present, model calibration to marsh stage is encouraging. Extensions and enhancements to these models are planned for 2006.

Canal Sediment Survey Update

Results from the first canal sediment survey effort (contract with University of Florida-IFAS) are presented in a preliminary report “L-40 Canal Sediment Elevation Study: Initial Report” posted on the SOFIA web site. This report describes four pre-discharge sediment elevation surveys conducted at five transect (Diaz and Waldon 2006).

A second component of this project involved studying changes in canal water quality by following and sampling water as it flows along the L-40 Canal. Sampling for this component has been delayed by weather conditions (including Hurricane Wilma) on three planned attempts. Therefore, these studies have been rescheduled for calendar year 2006.

Water Quality Data Analyses Updates

The Work Plan (Brandt et al. 2004) identifies several potential approaches for refining the network if there are appropriate technical underpinnings for doing so. Ultimately, any refinement of any monitoring network needs to have a sound technical basis before proceeding. First, we undertook an exercise to identify parameters for elimination because of redundancy in information or lack of contribution to the overall program goals. A draft report of this exercise was distributed to the Technical Oversight Committee and interested parties. The final version of this report was strengthened by technical input by individuals from a number of agencies. The final results of this exercise are available on the SOFIA web site, including a response to the technical comments received on the earlier draft. The refined list of parameters was completed for implementation in January 2006. Second, a draft report for examining potential station reduction is in development.

It is anticipated that this report will undergo a similar review before final station reduction recommendations are implemented in early 2006.

Transect water quality analyses (including the conductivity sonde data) are continuing.

Station Coordinates Update

The final QA of a complete set of differentially-corrected GPS coordinates of this enhanced network was completed in January 2006. The coordinates, along with very detailed metadata are available on the SOFIA web site, and have been submitted to the SFWMD for update in DBHYDRO.

Next Steps

The next steps for this program continue to focus on data collection and analysis and continuing forward with model development.

One of the bigger-picture management questions for the Refuge is: What impact does water management operations have on the ecology of the Refuge? This is challenging to answer because associating water management activities to interior marsh ecological conditions is complex. This question can be broken down into several components which are easier to understand (Figure 7). First, relationships between structure operations and water movement into and out of the perimeter canal needs to be examined. Second, the extent of water movement into the interior marsh from the canal needs to be determined.

Third, the relationship between canal/marsh water movement and the water quality of the interior marsh needs to be understood. Finally, relationships between water quality and ecology in the interior marsh need to be determined. Data from our Enhanced Water Quality program continue to be analyzed to help understand the middle two components. In 2006, we anticipate initiating new efforts to complement ongoing studies of ecological effects of water quality on the ecology of the interior marsh.

References

http://sofia.usgs.gov/lox_monitor_model/

Brandt, L.A., Harwell, M., Waldon, M. (2004) Work Plan: Water Quality Monitoring and Modeling for the A.R.M. Loxahatchee National Wildlife Refuge: 2004-2006. Prepared for the A.R.M. Loxahatchee National Wildlife Refuge. April, 2004. 33 pp.

Harwell, M. Surratt, D., Waldon, M., Walker, B., Brandt, L. (2005) A.R.M. Loxahatchee National Wildlife Refuge Enhanced Water Quality Monitoring and Modeling Interim Report. April, 2005. 106 pp.

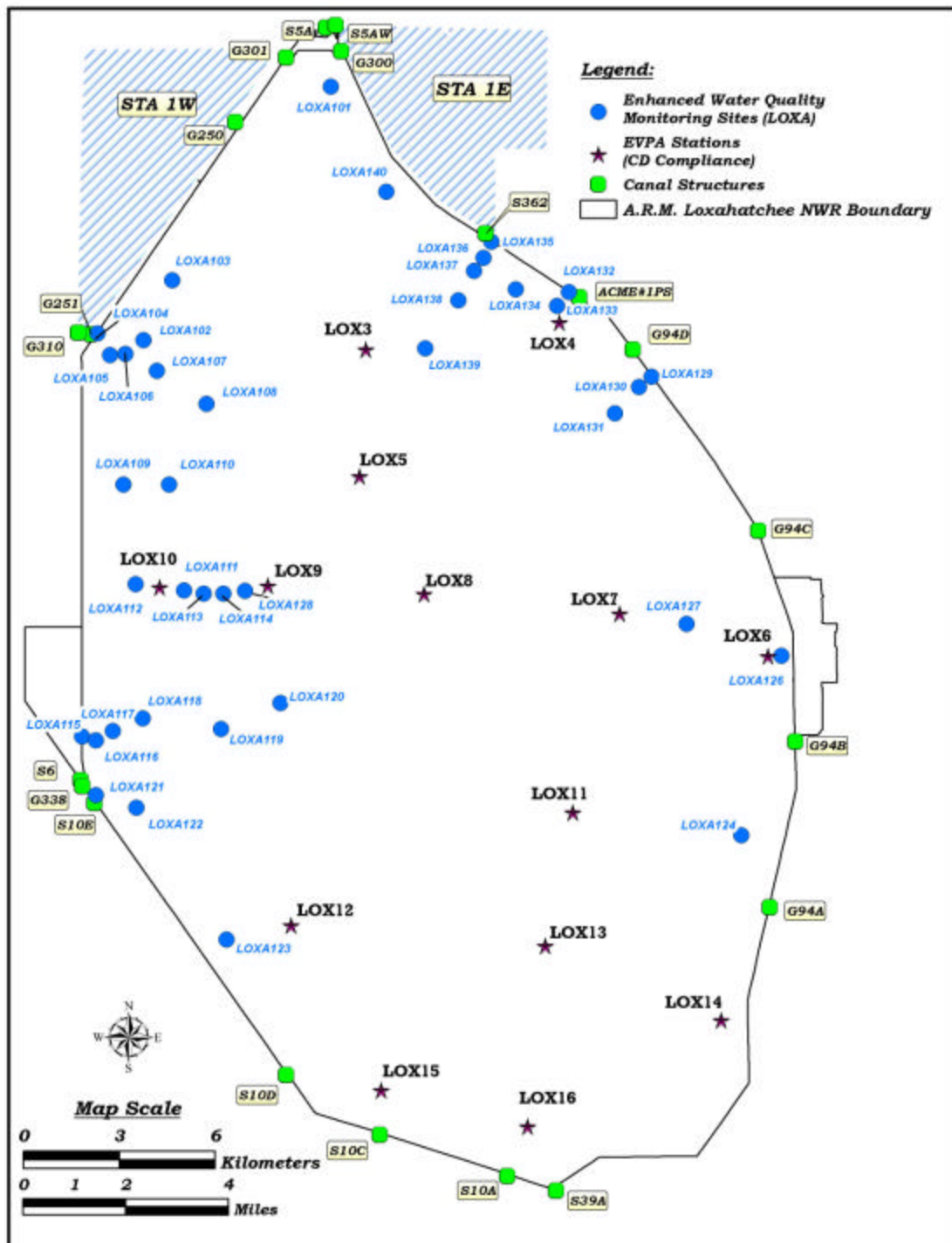


Figure 1. Location of Enhanced Water Quality Monitoring network stations (LOXA###), in relation to Consent Decree compliance stations (LOX##), for the A.R.M. Loxahatchee National Wildlife Refuge.

Table 1. 2005 Total phosphorus data (ppb) from the Enhanced Water Quality Monitoring Program for (a) marsh, and (b) canal stations for the A.R.M. Loxahatchee National Wildlife Refuge. Graphical representation of station locations are shown in Figure 1.

a) Marsh stations

Marsh Stations	Jan-05	Feb-05	Mar-05	Apr-05	May-05	Jun-05	Jul-05	Aug-05	Sept-05	Oct-05	Nov-05	Dec-05
LOXA101	11	11		25		58			18	13	14	12
LOXA102	11			9		16			7	10	10	8
LOXA103	15	42		16		21			7	8	14	10
LOXA105	17	23				41			18	18	17	12
LOXA106	10	14				21			9	13	18	10
LOXA107						23				9	10	7
LOXA108						28	12				8	8
LOXA109	9	8			18	13	5	9	8	8	9	7
LOXA110	24					18			8	8	8	6
LOXA111	22	12				19			6	7	10	7
LOXA112	10	12			18	15		8	7	9	8	8
LOXA113	9	17				13	5	3	5	7	8	6
LOXA114	15					25	6	6	5	7	8	5
LOXA116	47	32			53	60	19	31	24		30	19
LOXA117	8	12			16	35		13	15	19	17	9
LOXA118	6	6			16	17	6	9	7	10	8	6
LOXA119	12	5	44		52	32	5	6	6	7	7	5
LOXA120	12	7			102	34	4	6	5	8	7	5
LOXA121	91	117						49	55			54
LOXA122	9	12	16		29	14		12	11	12	11	8
LOXA123	9	9	18		36	17	7	12	11			10
LOXA124	9	15		106	300	24	13	7	16	11	13	7
LOXA126	7	10		10	59	26	6	6	11	16	11	8
LOXA127	6	7		12	31	10	6	7	8	7	7	7
LOXA128	11					29	7			8	6	5

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Marsh Stations	Jan-05	Feb-05	Mar-05	Apr-05	May-05	Jun-05	Jul-05	Aug-05	Sept-05	Oct-05	Nov-05	Dec-05
LOXA130	15	16		28	25	63	17	13	12	14	24	13
LOXA131	6	7		14	6	12		6	6	6	6	7
LOXA133	265			44		155			31			15
LOXA134	34	16		35	57	69	12	23	16	18	14	11
LOXA136	154	77		30		72			29			24
LOXA137	12	31	17	21	49	53	11	9	10	13	12	10
LOXA138	12	10		8	26	19	8		7	7	7	7
LOXA139						18	9	8		8	8	8
LOXA140	12	26		13		41	16		11	15	10	9
MAX	265	117	44	106	300	155	19	49	55	19	30	54
MIN	6	5	16	8	6	10	4	3	5	6	6	5

b) Canal stations

Canal Stations	Jan-05	Feb-05	Mar-05	Apr-05	May-05	Jun-05	Jul-05	Aug-05	Sept-05	Oct-05	Nov-05	Dec-05
LOXA104	93	100	92		62	195	77	67	62	71	190	134
LOXA115	51	100	94		47	129	64	48	50	91	188	106
LOXA129	60	81		68	222	258	95	58	74	85	117	73
LOXA132	61	88		75	117	286	78		65	51	137	68
LOXA135	66	79	115	68	99	216	66	55	54	40	112	80
Max	93	100	115	75	222	286	95	67	74	91	190	134
Min	51	79	92	68	47	129	64	48	50	40	112	68

Table 2. 2005 Conductivity sonde deployment information, separated by transect, for the A.R.M. Loxahatchee National Wildlife Refuge. X = data collected from sonde deployment during that month. Graphical representation of station locations are shown in Figure 1. Deployment information for December not available yet as sondes have not been retrieved.

Site ID	Description	2005											Month
		Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
LOXA104	NW Transect 0 (canal)	X	X	X	X	X	X	X	X	X	X	X	
LOXA105	NW Transect 0.5	X	X	X	X	X	X	X					
LOXA106	NW Transect 1	X	X	X	X	X	X	X	X	X	X	X	
LOXA107	NW Transect 2	X	X	X	X	X	X	X	X	X	X	X	
LOXA108	NW Transect 4	X	X	X	X	X	X	X	X	X	X	X	
LOXA111						X		X	X	X	X	X	
LOXA112		X	X	X	X	X		X	X	X	X	X	
LOXA113		X	X	X	X	X		X	X	X	X	X	
LOXA114													
LOXA115	SW Transect 0 (canal)	X	X	X	X	X	X	X	X	X			
LOXA116	SW Transect 0.5	X	X	X	X	X	X	X	X	X	X	X	
LOXA117	SW Transect 1	X	X	X	X	X	X	X	X	X	X	X	
LOXA118	SW Transect 2	X	X	X	X	X	X	X	X	X	X	X	
LOXA119	SW Transect 4	X	X	X	X	X	X	X	X	X			
LOXA120	SW Transect X5		X	X	X	X	X	X	X	X	X	X	
LOXA126		X	X	X	X	X	X	X	X	X	X	X	
LOXA127		X	X	X	X	X		X	X	X	X	X	
LOXA128													
LOXA129	NE Transect S 0 (canal)	X	X	X	X	X	X	X	X	X	X	X	
LOXA130	NE Transect S	X	X	X	X	X	X	X	X	X	X	X	
LOXA131	NE Transect S	X	X	X	X	X	X	X	X	X	X	X	
LOXA132	NE Transect N 0 (canal)	X	X	X	X	X	X	X	X	X	X	X	
LOXA133	NE Transect N	X	X	X	X	X	X	X	X	X	X	X	
LOXA134	NE Transect N												
LOXA135	NE Transect STA1E 0 (canal)	X	X	X	X	X	X	X	X	X	X	X	
LOXA136	NE Transect STA1E 0.5	X	X	X	X	X	X	X	X	X	X	X	
LOXA137	NE Transect STA1E 1	X	X	X	X	X	X	X	X	X	X	X	
LOXA138	NE Transect STA1E 2	X	X	X	X	X				X	X	X	
LOXA139	NE Transect STA1E 4	X	X	X	X	X	X	X	X	X	X	X	

Table 2 cont.

		2005							Month				
Site ID	Description	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
LOX4	EVPA site/refuge gauge	X	X	X	X	X	X	X	X	X	X	X	
LOX6	EVPA site	X	X	X	X	X	X		X	X	X		
LOX7	EVPA site	X	X	X	X	X		X	X	X	X		
LOX8	EVPA site	X	X	X	X	X					X	X	
LOX9	EVPA site	X	X	X	X	X	X		X		X		
LOX10	EVPA site	X	X	X	X	X		X	X		X		

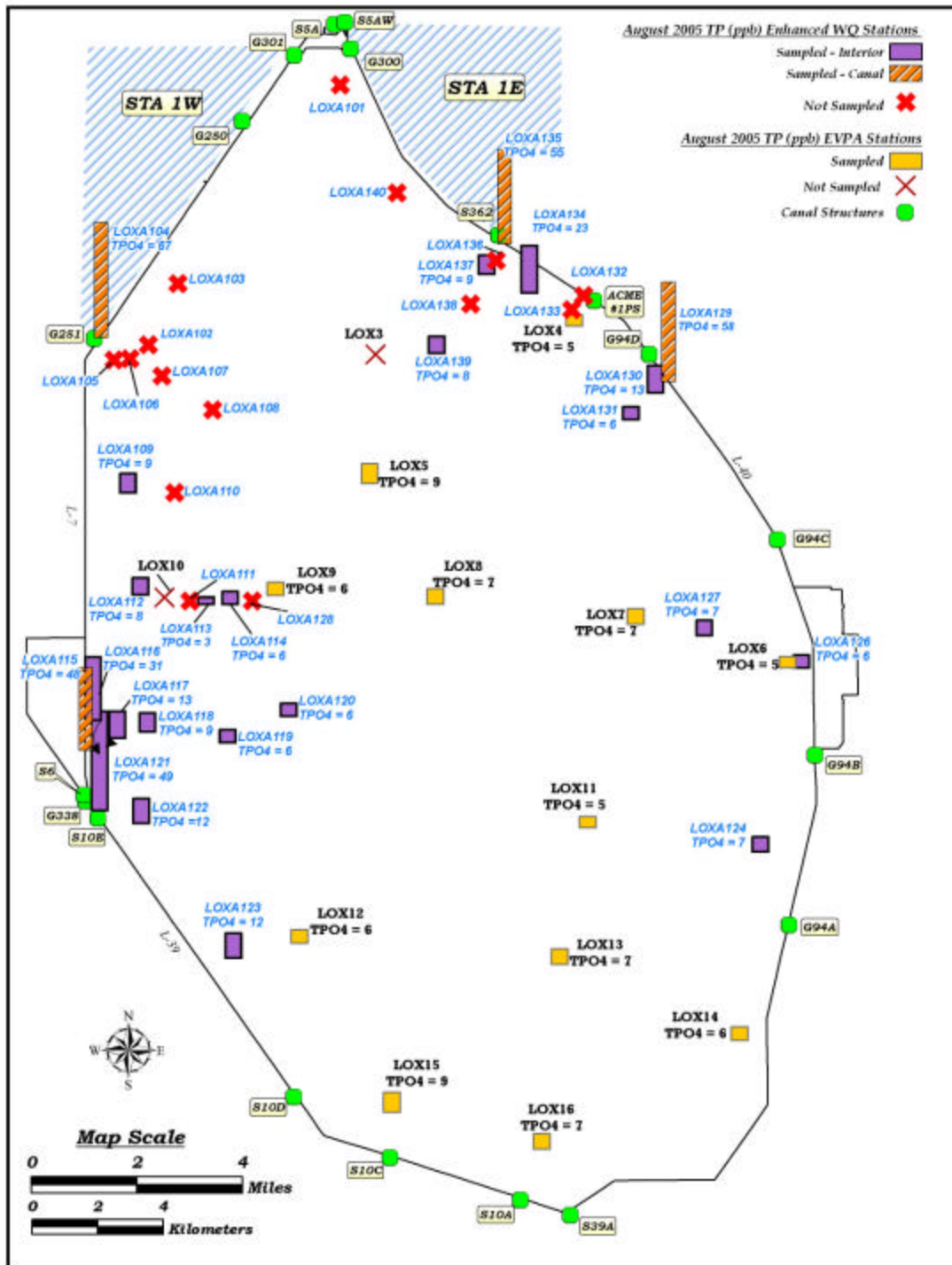


Figure 2. August 2005 map of total phosphorus values from the Enhanced Water Quality Monitoring and the EVPA stations in the A.R.M. Loxahatchee National Wildlife Refuge. A primary reason that a station is not sampled is that it has less than 10 cm of clear water column representative of that area.

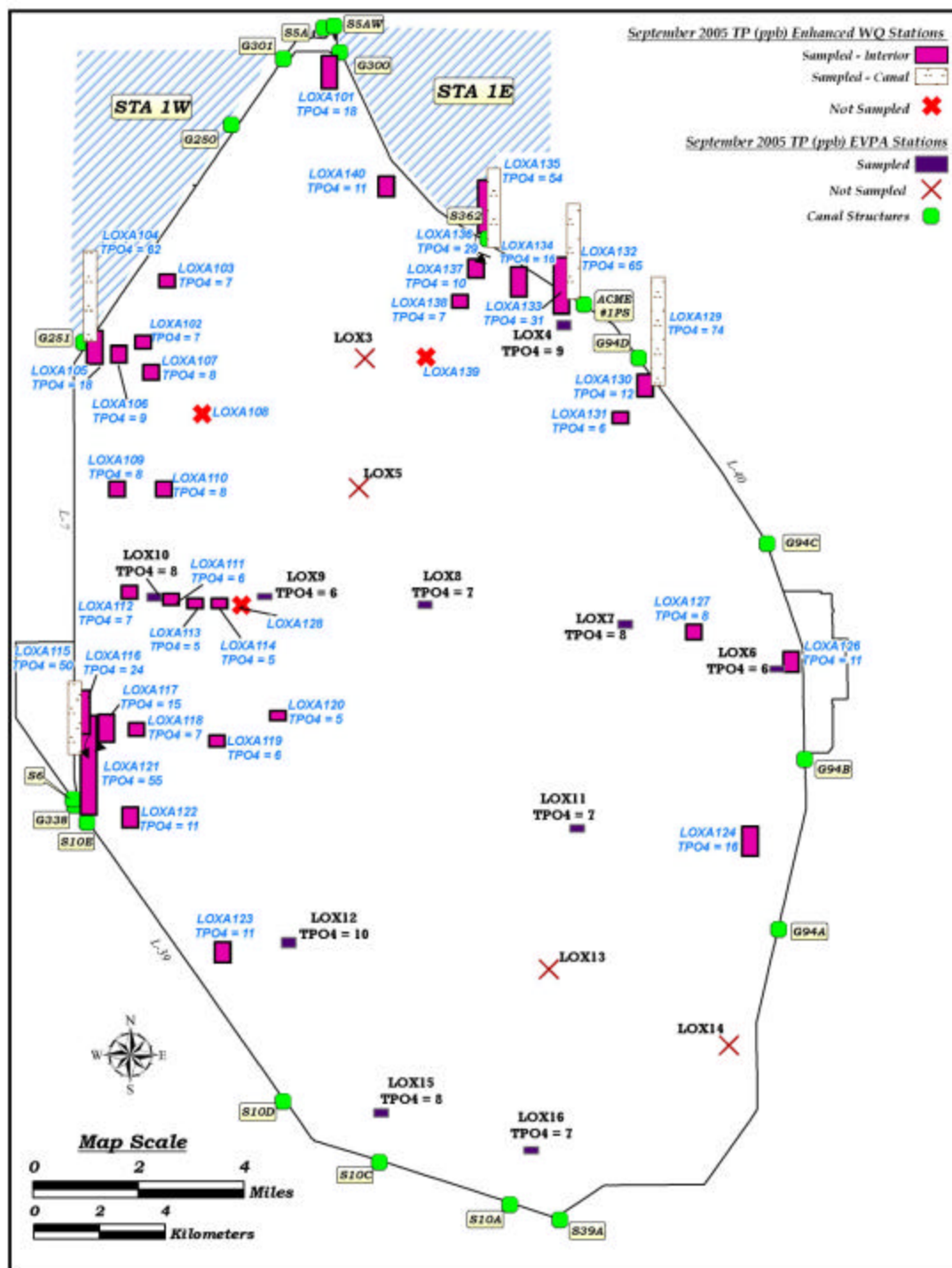


Figure 3. September 2005 map of total phosphorus values from the Enhanced Water Quality Monitoring and the EVPA stations in the A.R.M. Loxahatchee National Wildlife Refuge. A primary reason that a station is not sampled is that it has less than 10 cm of clear water column representative of that area.

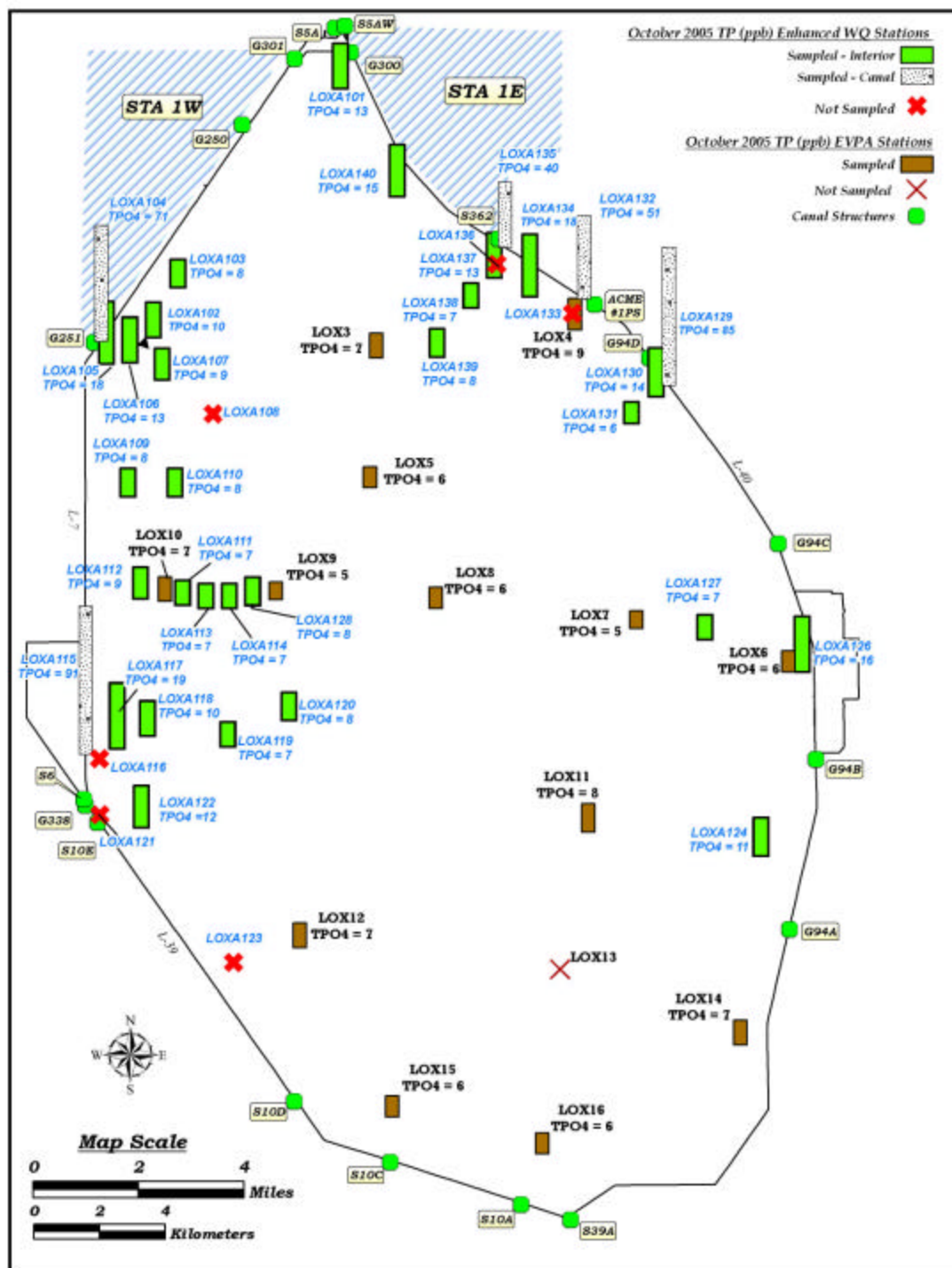


Figure 4. October 2005 map of total phosphorus values from the Enhanced Water Quality Monitoring and the EVPA stations in the A.R.M. Loxahatchee National Wildlife Refuge. A primary reason that a station is not sampled is that it has less than 10 cm of clear water column representative of that area.

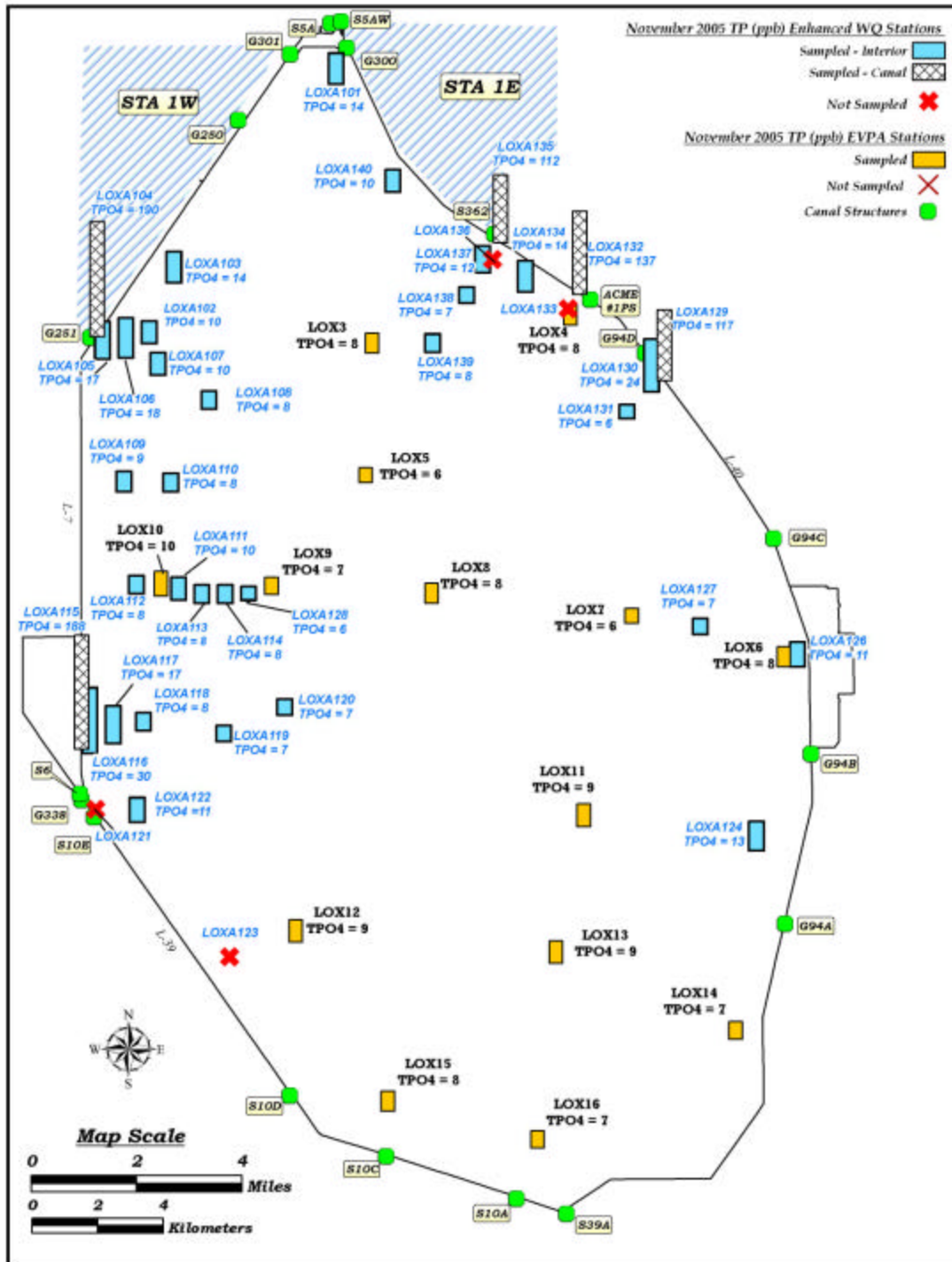


Figure 5. November 2005 map of total phosphorus values from the Enhanced Water Quality Monitoring and the EVPA stations in the A.R.M. Loxahatchee National Wildlife Refuge. A primary reason that a station is not sampled is that it has less than 10 cm of clear water column representative of that area.

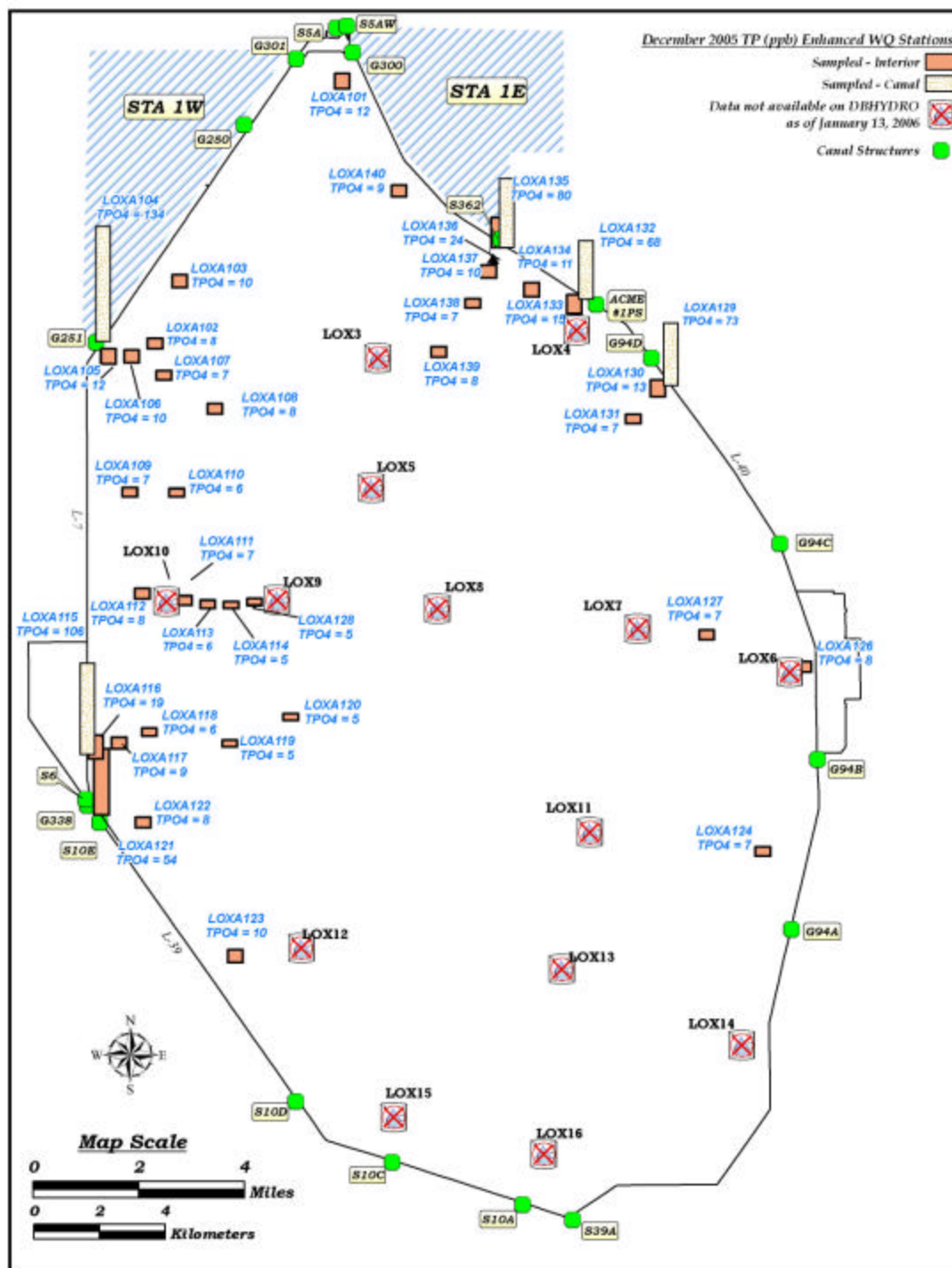


Figure 6. December 2005 map of total phosphorus values from the Enhanced Water Quality Monitoring and the EVPA stations in the A.R.M. Loxahatchee National Wildlife Refuge. A primary reason that a station is not sampled is that it has less than 10 cm of clear water column representative of that area. Note: December 2005 water quality data for the EVPA stations has not been made available at the time of this report.

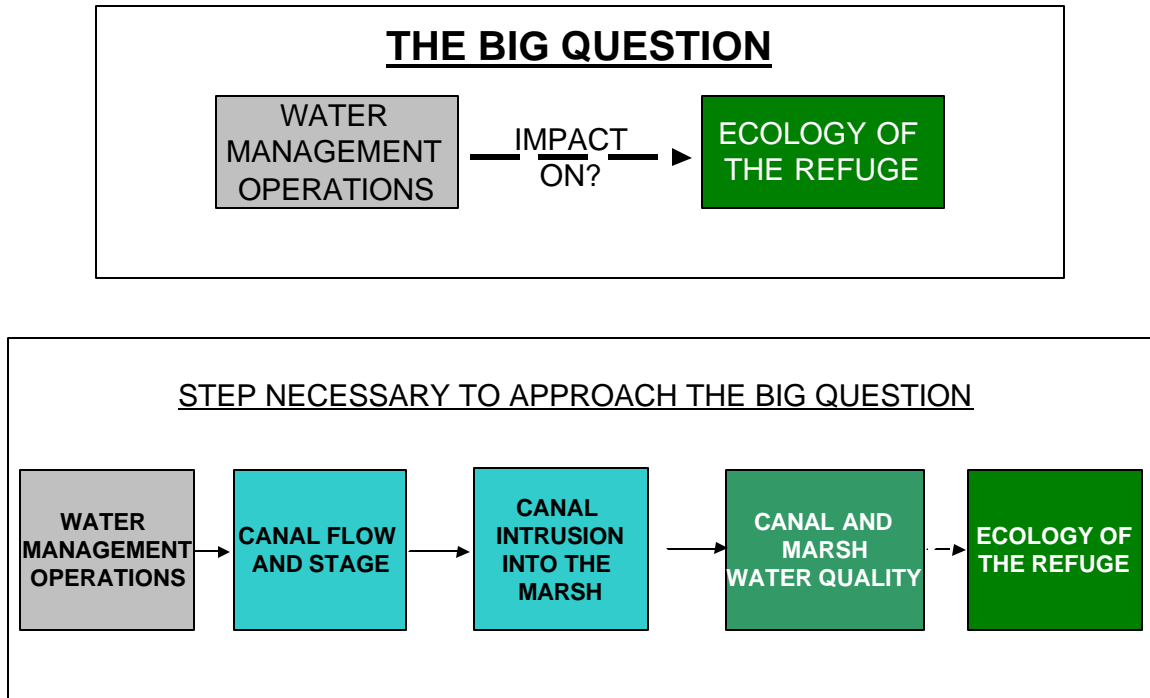


Figure 7. Conceptual diagram of the pieces involved with understanding the Refuge management question: What impact does water management operations have on the ecology of the Refuge?